inside the chapters greatly assist in understanding the complex subject matter. Not only the students of biophysics, but professionals dealing with biochemistry, cell biology and molecular biology will find this book eminently readable and highly informative due to its lucid explanation and easy organization of the huge amount of data from diverse fields of biophysics.

DULAL PANDA

School of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Mumbai 400 076, India
e-mail: panda@iitb.ac.in

Recent Advances in Earth System Sciences – Golden Jubilee Volume. Harsh Gupta and Fareeduddin (eds). Memoir No. 66, Geological Society of India, P.B. 1922, Gavipuram P.O., Bangalore 560 019. 2008. 674 pp. Price: Rs 1800/ $ 180.

The golden jubilee volume on *Recent Advances in Earth System Sciences* commemorating the 50th year of the Geological Society of India, attempts to showcase the progress made in geosciences over the last fifty years. One might as well call this as the 'progress made in earth sciences'. However, the editors of the volume, Harsh Gupta and Fareeduddin, in their introduction make a case for a system approach to link the disparate fields in earth sciences (and planetary sciences) and therefore, justify the title of the volume. The volume deals with wide ranging topics and many of them are India-centric articles. The authors of each of the articles, apparently chosen on the basis of their significant contributions to each field, discuss the current level of understanding of the individual topics and also highlight the gaps in our knowledge.

The first article in this volume is a contribution on lunar research, in which the author (Taylor, Australian National University) modestly states that it is intended as a commentary on the lunar science from an historical perspective rather than an in-depth review. However, the article most ably evaluates the origin of the moon on the basis of the compositional characteristics of its crust and mantle. The compositional difference between the moon and the earth suggests the involvement of an external body colliding with the early earth. The moon is believed to have been evolved from the mantle of this impactor while its core was subsumed by the earth. What is evocative in this discussion is the fact that hundreds of years of speculation about the moon was laid to rest merely by the 'classical' geological examination of a few samples brought down by lunar expeditions. The power of geology, I am sure, will be further tested in future manned missions to the moon and Mars which would certainly consist of a few geologists–astronauts or to be wistful, during an ultimate adventure when geologists land on an asteroid in a distant future, literally realizing Schumaker's dream of hitting it with a geological hammer. In a companion article, J. L. Carter discusses the efforts in artificially producing the lunar regolith, which would duplicate the real material. These materials are indispensable for the projects that aim at establishing a permanent manned station on the lunar surface sometime in the second decade of the 21st century, so that we get a grip on how the lunar dust interacts with humans and machines in the longer term. This is completely new information for me. The article discusses the problems of duplicating lunar materials using earth's materials as well as some successes. Here is a field that could attract both geologists and material scientists.

Since the plate tectonic revolution, a sort of monotony had set in amongst the practitioners of earth sciences, only to be rudely shaken by the discovery of yet another process that had been overlooked. The high-energy physicist and Nobelist Luis Alvarez together with his geologist son Walter, developed the theory that a giant asteroid hit the earth around 60 million years ago, killing all the dinosaurs, and wrote up a paper in 1980. I consider this as a momentous development in the history of post plate tectonic geological research, which galvanized the scientific community to look outward and see the earth's process from a planetary vantage point. When Fred Hoyle, perhaps in one of his whimsical moods, first suggested that the life was seeded on earth externally (known now as 'panspermia'), he was almost hooted down. Now, scientists do realize that the impact cratering by the extraterrestrial objects has implications for the life on earth and evolution and also on climate. W. Uwe Reimold and C. Koeberl chronicle the history of this field and discuss the current status and point to the future directions. The impact cratering science has ramifications for the entire planetary bodies as a major process that affects their evolution and survival. We have already read this in the case of the moon. Here again, classical geology is a major tool that can be used profitably to distinguish the impact structures, mainly by identifying shock metamorphic features.

The last fifty years also saw rapid strides in space technology, and earth scientists used this development to their greatest advantage, mainly to monitor the earth processes on a global scale from a vantage point. The satellite facilities have resulted in generating vast amounts of spatial data. A. Cazenave reviews progress in this area that has contributed to a better understanding of the earth's gravity field, sea-floor topography, plate motions, crustal deformation, water-balance estimates, ocean dynamics, sea-level changes (for example, we can now say conclusively that sea level is not rising uniformly), to quote a few. The author in her article has most appropriately included a water-level time series of the River Ganga over the period of 1993–2006, obtained from Topex/Poseidon satellite tracks. Such inputs are useful in predicting the hydrological variability and river discharges. It would have been useful to add a companion article from the Indian space researchers to inform us what they have been doing with such data in the Indian context. This volume also contains an article by R. H. Mitchell, a foremost specialist in the field, who provides the riveting story of the Kimberlite studies and explains how

geologists tried to understand the emplacement of enigmatic Kimberlite rocks (with embedded diamonds) sourced from the upper mantle.

Two articles in this volume deal with earthquakes and active tectonics of the Himalaya: by V. C. Thakur and V. K. Gahalaut respectively, with overlapping content, although the former looks at the problem from a geologist's perspective and the latter from a geodetic point of view. Both papers give a comprehensive review of the relevant studies (with some obvious omissions) and essentially support the traditional model of seismic gaps. It is possible that the traditional model of seismic gaps emanates from an assumption about a perfect arc deforming uniformly in response to plate convergence; consequently great earthquakes of magnitude >8.0 are expected to rupture regularly the 200–300 km long segments of the detachment plane in hundreds of years, while the intervening segments get locked, waiting to break. While the plate velocity and strain rates provide us a first-order constraint on the earthquake occurrences, it is important to take note of the second-order details, which are not sufficiently understood in the case of the Himalaya (or elsewhere for that matter, which explains why the Americans are drilling the San Andreas fault). Despite some much quoted papers, there are still many outstanding questions on the magnitudes of the past earthquakes, scaling relations, the internal structures of the wedges and their relation to causative structures that need to be resolved beyond doubt before the complexities of Himalayan tectonics can be 'shoehorned' (a phrase attributable to Stephen Jay Gould) to develop workable models of Himalayan seismogenesis. There is one more article on earthquakes in this volume by Harsh Gupta, a pioneer in the research on reservoir-induced (triggered) seismicity, which takes us to Koyna, a well-known natural laboratory of earthquakes. The author convincingly argues that the study of earthquakes at Koyna brings us closer to accurate, short-term earthquake forecasts. Supported by the recent occurrences of some predicted events, the ongoing studies hopefully will bring out more conclusively the underlying physics of such observations, and whether such results can be used in other areas.

The volume contains three articles on geodynamics: the first one deals with Archaean geodynamics based on the studies on Dharwar craton by S. M. Naqvi, who evaluates the geodynamic models applicable to the evolution of the Dharwar craton, one of the oldest pieces of land. How do these observations compare with other contemporary crusts elsewhere in the world? Are we able to get evidence for the proposed geodynamic model when the earth was in its infancy elsewhere too? Discussion on such questions would be interesting to a non-specialist. The second article by A. Sahni and G. V. R. Prasad tracks the movement of the Indian plate deciphered from the biotic imprints and fossil evidence; and the third article is presented by J. R. Curray and R. Allen on the evolution of the eastern Indian Ocean, which includes the Bay of Bengal and the Andaman and Sunda arc. Using varied evidence, all the three articles provide the reader an excellent account of the geodynamic evolution of the Indian terrains through various time intervals.

The climate and environmental research is also covered under a set of articles. Sulochana Gadgil's paper discusses the massive efforts by the researchers to understand the Indian monsoon. Thanks to the interest of the British administrators in Indian monsoon ('famine' politics played a big role in that), we had developed a network of meteorological observatories in the country very early on. The recent years have seen a great improvement in the ocean-based observations. Her major conclusion is that we need to cover a lot of distance to reach the goal of accurately predicting the monsoonal variability, although we have learned much on the physics of the process. One of the leading researchers in this area, she suggests that the emphasis should be to further understand the response of the Indian monsoon to the recurrent phenomena of equatorial Indian Ocean oscillation and El Nino Southern oscillation that are critical to the monsoonal forecasts or rather extreme variations. In another article (G. de Marsily), anthropogenic forcing, climate change and predicted water and food shortages are discussed. These predictions indicate that the hands of the geologists/hydrologists are going to be full in terms of managing aquifers, soil conservation and maintaining the ecosystems for years to come. An article on the Late Quaternary evolution of the Ganga basin (S. K. Tandon *et al.*), therefore, is relevant in this background. It looks at the basin dynamics through a systems approach and the inputs are important for river-basin management.

The volume also contains papers on geophysical studies, which include gravity study programmes (D. C. Mishra *et al.*) and seismic imaging studies (H. C. Tiwari). There are also articles on Deep Sea Drilling Programme (M. Talwani), cosmogenic nuclides and their applications (S. Krishnaswami and D. Lal), petroliferous basins of India (S. K. Biswas) and Antarctic studies (R. Ravindra). All these papers provide the state-of-the art in each field and are relevant in a volume that celebrates the 50th year of the Geological Society of India. While congratulating the Society and the editors for bringing out a timely tome that reflects the status of Indian earth science and its future directions, I may point out some omissions. Most striking is the absence of articles on geochronological advances and studies on the South Indian granulite terrain (in particular the metamorphic petrology). About the latter, I think Indian researchers have made substantial and highly rated contributions in its understanding during the last twenty-five years. Even the last summing-up article (B. Chattopadhyay) titled 'Selected advances in geology and the Indian scenario' could not do much justice to these topics that they deserved.

The concepts in science are neither absolute nor everlasting. Every theory needs to be tested with our experience and looked afresh in the light of new data. Fifty years from now on the Geological Society would be celebrating its 100th year. It is anybody's guess which of the existing ideas would survive to see that day. Thanks to the newer technological developments, including space voyages, geology has transformed to be a born-again science and the present volume is a bold attempt to share that excitement.

C. P. RAJENDRAN

Centre for Earth Sciences,
Indian Institute of Science,
Bangalore 560 012, India
e-mail: cprajendran@ceas.iisc.ernet.in